

IN THE CLAIMS

Please amend the claims as follows:

Claim 1 (Currently Amended): A chemical reaction system for performing chemical reactions of a target substance comprising a chemical reaction part which is composed of an oxygen ion conductor as an [[( )]ion conduction phase[( )]] and two electrodes, a corresponding cathode as a [[( )]reduction phase[( )]] and anode as an [[( )]oxidation phase[( )]] with the ion conduction phase therebetween, as basic units,

wherein

1) micro reaction regions where oxidation-reduction reactions of the target substance take place are introduced into a part of the chemical reaction part by applying current, voltage, or heat treatment in a reducing atmosphere or under a reduced pressure to the points of a contact between the ion conduction phase and an electron conduction phase, the points are composed of at least one conductor selected from the group consisting of an ion conductor, an electron conductor and a mixed electrical conductor in the chemical reaction part,

2) interfaces consisting of a metal phase of the electron conduction phase, an oxygen deficient part of the ion conduction phase and micro spaces (gaps) surrounding the contact points are formed as the micro reaction regions, and

3) a working electrode layer to manage oxidation-reduction reactions is formed in the upper part of the cathode, and the micro reaction regions of nanometers to a micrometer in size where the oxidation-reduction reactions take place are introduced into the same working electrode layer,

wherein a reaction temperature in the chemical reaction system is from 400 °C to 700 °C.

Claim 2 (Canceled).

Claim 3 (Original): The chemical reaction system according to Claim 1, wherein micro reaction regions where the oxidation-reduction reactions take place are introduced into the cathode.

Claim 4 (Canceled).

Claim 5 (Original): The chemical reaction system according to Claim 1, wherein a substance making up all or part of the micro reaction regions has an oxidizing or reducing effect on the target substance.

Claim 6 (Original): The chemical reaction system according to Claim 1, wherein the metal phase consists of ultrafine particles of a metal phase produced by an oxidation-reduction reaction generated across some or all of an electron conductor or mixed electrical conductor by subjecting the chemical reaction system to current or heat treatment in a reducing atmosphere.

Claim 7 (Original): The chemical reaction system according to Claim 1, wherein the oxygen deficient part consists of an oxygen deficient layer produced by an oxidation-reduction reaction generated across some or all of an ion conductor or mixed electrical conductor by subjecting the chemical reaction system to current or heat treatment in a reducing atmosphere.

Claim 8 (Original): The chemical reaction system according to Claim 1, having a structure in which the ion conductor and electron conductor contact each other in at least one place to constitute the micro reaction regions, or in which they contact each other in the manufacturing process thereof.

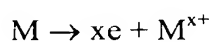
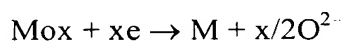
Claim 9 (Original): The chemical reaction system according to Claim 1, wherein a barrier layer of a substance capable of interrupting electron conduction is included on the pathway which the target substance travels from the electrochemical cell surface to the space where the chemical reaction takes place.

Claim 10 (Original): The chemical reaction system according to Claim 1, wherein the chemical reaction is a conversion reaction of matter or energy.

Claim 11 (Original): The chemical reaction system according to Claim 1, wherein the target substance is nitrogen oxides.

Claim 12 (Original): The chemical reaction system according to Claim 10, wherein the chemical reaction is reduction degradation of nitrogen oxides.

Claim 13 (Original): The chemical reaction system according to Claim 9, wherein a chemical reaction represented by the following general formula:



(where M is a metal, O is an oxygen atom and e is an electron) is generated in the chemical reaction system.

Claim 14 (Withdrawn): A method for manufacturing the chemical reaction system as claimed in Claim 1 comprising introducing micro reaction regions where oxidation-reduction reactions of a target substance take place into a chemical reaction part by applying current or heat treatment in a reducing atmosphere to the points of contact between an ion conduction phase and an electron conduction phase composed of a combination of any of an ion conductor, an electron conductor and a mixed electrical conductor in the chemical reaction part.

Claim 15 (Withdrawn): The method according to Claim 14, wherein when the substances contact each other to form an interface, one or both of them is in a reduced state.

Claim 16 (Withdrawn): A method for activating a chemical reaction system, wherein in the chemical reaction system according to Claim 1, pairs are formed of metal phase parts of an electron conduction phase or mixed electrical conduction phase and oxygen deficient parts of an ion conduction phase or mixed electrical conduction phase.

Claim 17 (Withdrawn): A chemical reaction system in which the chemical reaction part is composed of 1) an oxygen ion conductor (ion conduction phase), a corresponding cathode (reduction phase) and anode (oxidation phase) with the ion conduction phase therebetween or 2) an oxidizing and/or reducing catalyst as basic units for performing chemical reactions of a target substance, wherein the chemical reaction part is subjected to current or voltage or to heat treatment in a reducing atmosphere or under reduced pressure to activate the ability to ionize and remove oxygen which impedes reactions when adsorbed by the chemical reaction part.

Claim 18 (Withdrawn): The chemical reaction system according to Claim 17, wherein a chemical reaction part having a reduction layer which has selectively for both oxygen and a target substance, respectively and holes a micrometer or less in size which are necessary for efficiently supplying and processing the target substance in the reduction phase is used as the chemical reaction part.

Claim 19 (Withdrawn): The chemical reaction system according to Claim 17, wherein a chemical reaction part having micro reaction regions where oxidation-reduction reactions of a target substance take place introduced into part of the chemical reaction part by applying current, voltage, or heat treatment in a reducing atmosphere or under reduced pressure to the points of contact between an ion conduction phase and an electron conduction phase composed of a combination of any of an ion conductor, an electron conductor and a mixed electrical conductor is used as the chemical reaction part.

Claim 20 (Withdrawn): The chemical reaction system according to Claim 19, wherein a chemical reaction part is used in which interfaces consisting of metal parts of the electron conduction phase, oxygen deficient parts of the ion conduction phase and micro spaces (gaps) surrounding the points of contact of these are formed as the micro reaction regions.

Claim 21 (Withdrawn): The chemical reaction system according to Claim 19, wherein a chemical reaction part having micro reaction regions where the oxidation-reduction reactions take place introduced into the cathode is used as the chemical reaction part.

Claim 22 (Withdrawn): The chemical reaction system according to Claim 17, wherein a chemical reaction part having a working electrode layer for managing oxidation-reduction reactions in the upper part of the cathode and micro reaction regions nanometers to a micrometer in size where the oxidation-reduction reactions take place introduced into the same layer is used as the chemical reaction part.

Claim 23 (Withdrawn): The chemical reaction system according to Claim 17, wherein the target substance is nitrogen oxides.

Claim 24 (Withdrawn): The chemical reaction system according to Claim 22, wherein the chemical reaction is reduction degradation of nitrogen oxides.

Claim 25 (Withdrawn): A method for using a chemical reaction system for performing chemical reactions of a target substance as claimed in Claim 17, comprising maintaining the temperature of the system at 400 to 700°C, or raising or lowering the temperature within this temperature range in the chemical reaction system, and applying current or voltage at intervals of time to activate the chemical reaction part.

Claim 26 (Withdrawn): A method for activating a chemical reaction system for performing chemical reactions of a target substance as claimed in Claim 17, comprising maintaining the temperature of the system at 400 to 700°C, or raising or lowering the temperature within this temperature range in the chemical reaction system, and applying current or voltage treatment between the cathode and anode for 1 minute to 3 hours.

Claim 27 (Withdrawn): The method for activating a chemical reaction system according to Claim 26, wherein an electrochemical reaction is generated by applying 5 mA to 1 A current or 0.5 V to 2.5 V voltage.

Claim 28 (Withdrawn): The method for activating a chemical reaction system according to Claim 26, wherein current or voltage treatment is performed in an oxygen partial pressure of 0% to 21% (in atmosphere).

Claim 29 (Withdrawn): A method for activating a chemical reaction system for performing chemical reactions of a target substance as claimed in Claim 17, comprising maintaining the temperature of the system at 500°C or more, or raising or lowering the temperature within this temperature range in the chemical reaction system, and heat treating the system in a reducing atmosphere or under reduced pressure.

Claim 30 (Withdrawn): A reaction method which is an oxidation-reduction reaction method using an oxidation-reduction reactor composed of a solid electrolyte oxygen ion conductor and at least an electrode consisting of an electron conductor, comprising producing the cathode provided with reductant (R) and reduction product  $AO_{x-y}$  (where  $0 < y \leq x$ ) by an oxidation-reduction reaction of oxide  $AO_x$  and reductant (R) based on the reaction formula  $AO_x + R \rightarrow RO_y + AO_{x-y}$ , or producing the anode provided with oxidant ( $R'O_x$ ) and oxide  $AO_y$  by an oxidation-reduction reaction of compound A and oxidant ( $R'O_x$ ) based on the reaction formula  $A + R'O_x \rightarrow R'O_{x-y} + AO_y$ .

Claim 31 (Withdrawn): The reaction method according to Claim 30, wherein the cathode is provided with a reductant (R) consisting of a metal or suboxide, (1) oxide  $AO_x$

(where  $x$  is  $1/2$  the oxidation number of A) is introduced into the reactor and the reduction product  $AO_{x-y}$  (where  $0 < y \leq x$ ) is produced by an oxidation-reduction reaction of oxide  $AO_x$  and reductant (R) based on the reaction formula  $AO_x + R \rightarrow RO_y + AO_{x-y}$ , and (2) current is supplied to the electrode and the oxidized reductant ( $RO_y$ ) is reduced by the electrochemical reaction represented by the reaction formulas  $y2e^- + RO_y \rightarrow R + yO^{2-}$  (cathode) and  $yO^{2-} \rightarrow y/2 O_2 \uparrow + y2e^-$  (anode) to restore the reductant (R).

Claim 32 (Withdrawn): The reaction method according to Claim 31, wherein current is supplied to the electrode to restore the reductant (R) either after or simultaneously during production of the reduction product  $AO_{x-y}$  (where  $0 < y \leq x$ ) by an oxidation-reduction reaction of oxide  $AO_x$  and reductant (R).

Claim 33 (Withdrawn): The reaction method according to Claim 32, wherein the reductant (R) is a nitrogen oxide reductant, and a reduction product of  $N_2$  is produced by an oxidation-reduction reaction of the nitrogen oxide reductant and the nitrogen oxide  $NO_x$  based on the reaction formula  $NO_x + R \rightarrow RO_x + x/2N_2$  to remove the  $NO_x$ .

Claim 34 (Withdrawn): The reaction method according to Claim 33, wherein the oxidation-reduction reactor comprises a nitrogen oxide reductant consisting of metals or suboxides 50% or more of which comprises one or more elements selected from Ni, Cu and Fe, an electrode consisting of an electron conductor which is one or more selected from Au, Pt, Ag, Pd, a Ni oxide, a Cu oxide, a Fe oxide and a Mn oxide, and a solid electrolyte oxygen ion conductor consisting of zirconium oxide.



Claim 35 (Withdrawn): The reaction method according to Claim 33, wherein the size of the nitrogen oxide reductant is 10 nm to 1  $\mu\text{m}$ .

Claim 36 (Withdrawn): The reaction method according to Claim 33, wherein an oxide electron conductor which is one or more selected from a Ni oxide, a Cu oxide, an Fe oxide and a Mn oxide is brought into contact with a solid electrolyte oxygen ion conductor, and cathode current is supplied to the electron conductor to reduce part of the oxide electron conductor and form a nitrogen oxide reductant 10 nm to 1  $\mu\text{m}$  in size.

Claim 37 (Withdrawn): The reaction method according to Claim 30, wherein the anode is provided with an oxidant ( $\text{R}'\text{O}_x$ ) consisting of an oxide, (1) compound A is introduced into the reactor and oxide  $\text{AO}_y$  is produced by an oxidation-reduction reaction of compound A and oxidant ( $\text{R}'\text{O}_x$ ) based on the reaction formula  $\text{A} + \text{R}'\text{O}_x \rightarrow \text{R}'\text{O}_{x-y} + \text{AO}_y$ , and (2) current is supplied to the electrode and the reduced oxide  $\text{R}'\text{O}_{x-y}$  is oxidized by the electrochemical reaction represented by the reaction formulas  $y\text{O}^{2-} + \text{R}'\text{O}_{x-y} \rightarrow \text{R}'\text{O}_x + y2\text{e}^-$  (anode) and  $y2\text{e}^- + \text{O}_2 \rightarrow y2\text{O}^{2-}$  (cathode) to restore the oxidant ( $\text{R}'\text{O}_2$ ).

Claim 38 (Withdrawn): The reaction method according to Claim 37, wherein current is supplied to the electrode to restore the oxidant ( $\text{R}'\text{O}_x$ ) either after or simultaneously during production of the oxide  $\text{AO}_y$  by an oxidation-reduction reaction of compound A and oxidant ( $\text{R}'\text{O}_x$ ).

Claim 39 (Withdrawn): The reaction method according to Claim 37, wherein compound a is a hydrocarbon or organochlorine compound.

Claim 40 (Previously Presented): The chemical reaction system according to Claim 1, wherein the ion conduction phase comprises a solid electrolyte having an oxygen ion conductivity.

Claim 41 (Previously Presented): The chemical reaction system according to Claim 1, wherein the oxidizing phase contains a conductive substance that causes electrons to be released from ions from the ion conduction phase.

Claim 42 (Previously Presented): The chemical reaction system according to Claim 1, wherein an electrically conductive substance is at least one selected from the group consisting of platinum, palladium, nickel oxide, cobalt oxide, copper oxide, lanthanum manganite, lanthanum cobaltite, and lanthanum chromite.

Claim 43 (Previously Presented): The chemical reaction system according to Claim 1, wherein an ion conductive substance is at least one selected from the group consisting of zirconia stabilized with yttria, scandium oxide, ceria, lanthanum gallate stabilized with gadolinium oxide, and samarium oxide.

Claim 44 (Previously Presented): The chemical reaction system according to Claim 9, wherein the barrier layer is an ion conductor, a mixed electrical conductor or an insulator.

Claim 45 (Previously Presented): The chemical reaction system according to Claim 1, wherein the target substance is nitrogen oxide in an exhaust gas.

Claim 46 (Previously Presented): The chemical reaction system according to Claim 1, wherein the chemical reaction system is in a form of a pipe, plate or honeycomb.

Claim 47 (Previously Presented): The chemical reaction system according to Claim 1, wherein the reduction phase is porous.

Claim 48 (Previously Presented): The chemical reaction system according to Claim 40, wherein the solid electrolyte is an oxygen ion conductor having a conductivity of  $10^{-6} \Omega^{-1}$  or greater.

Claim 49 (Previously Presented): The chemical reaction system according to Claim 9, wherein the solid electrolyte is an oxygen ion conductor comprising at least one oxide selected from the group consisting of  $\text{ZrO}_2$ ,  $\text{CeO}_2$ ,  $\text{Bi}_2\text{O}_3$  and  $\text{LaGaO}_3$ .

Claim 50 (New): The chemical reaction system according to Claim 1, wherein an applied current is from 5 mA to 1A or an applied voltage is from 0.5 V to 2.5 V.

Claim 51 (New): The chemical reaction system according to Claim 1, wherein the chemical reaction system can decompose 50% of  $\text{NO}_x$  at the current density of  $31 \text{ mA/cm}^2$  or less.

Claim 52 (New): The chemical reaction system according to Claim 1, wherein the reaction temperature in the chemical reaction system is from  $400^\circ\text{C}$  to less than  $700^\circ\text{C}$ .